

Filed by Express Mail
(Receipt No. 32224937645)
on January 07 2004
pursuant to 37 C.F.R. 1.10.
by [Signature]

TITLE OF THE INVENTION

CONNECTION MANAGEMENT APPARATUS FOR
NETWORK DEVICES

5 CROSS-REFERENCE TO RELATED APPLICATIONS

The present application is based on
Japanese priority application No. 2003-068632 filed
March 13, 2003, the entire contents of which are
hereby incorporated by reference.

10

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention generally relates to
a connection management apparatus for network
15 devices, and more particularly to a connection
management apparatus that can integrally accommodate
configuration in which connection paths of network
devices differ for individual users.

2. Description of the Related Art

20 FIG. 1 is a block diagram illustrating a
typical structure of a conventional connection
management apparatus for network devices. As shown
in FIG. 1, one or more users are connected to a
router 10 via an IP (Internet Protocol) network.
25 The router 10 is connected to a layer-2 switch 11.
The layer-2 switch 11, in turn, is connected to a
server 15 and various network devices such as a
firewall (FW) 12, a SLB (Server Load Balancing)
device 13 and a SSL (Secure Sockets Layer) device 14.

30 Conventional connection management
apparatuses for network devices allow for different
connection paths of the network devices for
individual users. However, when the connection path
of a user is changed, it is necessary to physically
35 rearrange network cables corresponding to the change.

Japanese Laid-Open Patent Application No.
2002-111712 discloses a communication apparatus that

can implement a transferring process between VLANs
(Virtual Local Area Networks), a multi-protocol
transferring process, especially, a connection
process between separate networks and an editing
5 process on packet headers in a hardware fashion.

In recent years, there have been an
increasing number of services to build networks
corresponding to individual users, for example,
Internet Data Center (iDC) as appreciated by those
10 skilled in the art, and rent not only installation
areas and power supplies of network devices but also
the network devices themselves. When a user starts
to utilize such an iDC service, the iDC needs to
physically connect or arrange rented network devices
15 in accordance with connection paths that the user
desires.

In this case, under circumstances where
users quite frequently go in and come from an iDC
service, it is necessary to physically rearrange
20 connection paths in response to frequent incoming
and outgoing behavior, thereby increasing
operational costs such as a labor cost and the
number of operational steps. In addition, in a case
where similar type network devices are used but
25 connection paths are different for individual users,
whenever a user having a connection path different
from already registered users is joined, it is
necessary to newly add another physically different
network structure, thereby resulting in additional
30 problems such as increases in installation areas.

In order to prevent physical changes of
connection paths, there is an approach to logically
set connection paths. In this approach, however, in
order to change a connection path of a user, it is
35 necessary to change current configurations of
network devices that are located in the connection
path. For example, if connections among the network

devices shown in FIG. 1 are set in accordance with VLAN, it is necessary to change IP addresses of devices that are set to be connected next to the router 10, the layer-2 switch 11, the firewall 12, the SLB device 13 and the SSL device 14. Thus, this configuration change is troublesome task.

SUMMARY OF THE INVENTION

It is a general object of the present invention to provide a connection management apparatus for network devices in which one or more the above-mentioned problems are eliminated.

A more specific object of the present invention is to provide a connection management apparatus for network devices that can easily change connection paths of the network devices for individual users, thereby decreasing the number of steps required to add and change a connection path.

In order to achieve the above-mentioned objects, there is provided according to one aspect of the present invention a connection management apparatus for connecting a plurality of physically connectable network devices based on connection paths set for individual users, including: a client port connectable to the users via a network; a server port connectable to a server; a lookup table including one or more pairs of tags and destination addresses, each of said pairs indicating a user and a next destination of a received packet by using a tag attached to the received packet as a search key wherein the attached tag indicates a user and a destination; and a tag replacement and transmission part replacing a tag of the received packet with a tag detected from the lookup table and transmitting the resulting packet to a destination address detected from the lookup table; wherein a packet received from one of the users and the server is

transmitted to one of the plurality of network devices and a packet received from one of the plurality of network devices is transmitted to one of the plurality of network devices, the server and
5 the users.

According to one aspect of the present invention, it is possible to easily change connection paths of network devices for individual users, thereby decreasing the number of steps
10 required to add and change a connection path.

In an embodiment of the present invention, the plurality of network devices may be connected in a star topology.

According to one aspect of the present invention, it is possible to change connection paths of network devices by using a lookup table in
15 accordance with necessity.

In an embodiment of the present invention, in the lookup table search keys may be grouped for
20 each of the users.

According to one aspect of the present invention, it is possible to easily change connection paths of network devices for individual users.

In an embodiment of the present invention, in the lookup table the search keys may further be grouped for each of an up-directional connection path of a packet transmitted from a client side to a server side and a down-directional connection path
25 of a packet transmitted from the server side to the client side.
30

According to one aspect of the present invention, it is possible to easily change connection paths of network devices for each of an
35 up-directional connection path and a down-directional connection path.

In an embodiment of the present invention,

the lookup table may further include one or more physical ports corresponding to search keys together with the pairs of tags and destination addresses each of which indicates a user and a next
5 destination.

According to one aspect of the present invention, it is possible to obtain information on physical ports via which a packet is transmitted.

In an embodiment of the present invention,
10 the lookup table may be rewritable through a terminal.

In an embodiment of the present invention, the tag may be a VLAN tag.

Other objects, features and advantages of
15 the present invention will become more apparent from the following detailed description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

20 FIG. 1 is a block diagram illustrating a typical structure of a conventional connection management apparatus for network devices;

FIG. 2 is a schematic view of a connection management apparatus for network devices according
25 to one embodiment of the present invention;

FIG. 3 is a block diagram of an exemplary structure of a connection management apparatus for network devices according to one
embodiment of the present invention;

30 FIG. 4 is a diagram illustrating an exemplary arrangement of a destination lookup table of a management mechanism according to one embodiment of the present invention;

FIG. 5 is a flowchart of an exemplary
35 connection operation performed by the management mechanism according to one embodiment of the present invention;

FIG. 6 is a flowchart of an exemplary connection operation performed by a processing block according to one embodiment of the present invention;

5 FIG. 7 is a diagram illustrating exemplary flow of an up-directional packet according to one embodiment of the present invention;

 FIG. 8 is a diagram illustrating exemplary flow of an down-directional packet according to one
10 embodiment of the present invention; and

 FIG. 9 is a diagram for explaining an exemplary change operation of the destination lookup table according to one embodiment of the present invention.

15

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the following, embodiments of the present invention will be described with reference to the accompanying drawings.

20 FIG. 2 is a schematic view of a connection management apparatus for network devices according to one embodiment of the present invention. FIG. 3 is a block diagram of an exemplary structure of a connection management apparatus for network devices
25 according to one embodiment of the present invention.

Referring to FIG. 3, a management mechanism 20 uses a destination lookup table 22 to manage connection paths for individual users. The management mechanism 20 also has a conventional
30 layer-2 switch function. As shown in FIG. 3, the management mechanism 20 includes physical ports Pin, Pout, and P1 through Pn. The physical port Pin is connected to a router in the client side, that is, a router that is connected to an IP network. The
35 physical port Pout is connected to a server. The physical ports P1 through Pn are connected to processing blocks (HLB) 24-1 through 24-n,

respectively.

Referring to FIG. 2, the management mechanism 20 and the processing blocks 24-1 through 24-n together with the router 25 are accommodated within a housing 26. In one embodiment of the present invention, a tag VLAN (Virtual Local Area Network) is used to manage connections between a connection management apparatus and individual processing blocks. In addition, the VLAN tag is used to identify flow of a packet supplied from the client side for each pair of a user and a destination. Accordingly, for example, a packet from user A is supplied to the server 27 via the processing blocks 24-1, 24-2, ..., 24-n, as illustrated by the solid arrow in FIG. 2. Also, a packet from user B is supplied to the server B via the processing blocks 24-2, ..., 24-n, as illustrated by the dashed arrow in FIG. 2.

The individual processing blocks 24-1 through 24-n shown in FIG. 3 operate in accordance with an operation policy of each user. For example, some of the processing blocks 24-1 through 24-n may work as firewalls, SLB devices and SSL devices.

In FIG. 3, the notation "Line₁" through "Line_n" represent physical connection lines. The notations "VLAN_{in}", "VLAN_{out}" and "VLAN₁" through "VLAN_n" represent VLAN tags of the respective blocks. The notation "M₀" through "M_n" represent respective MAC (Media Access Control) addresses for the connection management apparatus and the processing blocks 24-1 through 24-n, respectively. In this embodiment, the management mechanism 20 has a star topological connection configuration in order to collectively manage connection paths.

As mentioned above, the management mechanism 20 includes the destination lookup table 22. The management mechanism 20 searches the

destination lookup table 22 by using VLAN tags attached to input packets as search keys. In this embodiment, the destination lookup table 22 is configured to be rewritable in accordance with
5 instruction from a terminal 30.

FIG. 4 shows an exemplary arrangement of the destination lookup table 22 of the management mechanism 20 according to one embodiment of the present invention.

10 Referring to FIG. 4, by using search keys (VLAN tags of 32 bits) as entries, destination VLAN tags of 32 bits, destination MAC addresses of 48 bits and physical ports are registered in the destination lookup table 22. In this embodiment,
15 destination VLAN tags detected from the destination lookup table 22 are used as the search keys at the next step. Thus, it is possible to maintain processing block link information in which an up-directional connection path and a down-directional
20 connection path are successively described. Here, it is noted that the up-directional connection path means the connection path of a packet transmitted from the client side to the server side. On the other, the down-directional connection path means
25 the connection path of a packet transmitted from the server side to the client side.

In this embodiment, the search keys for the destination lookup table 22 are grouped for each user, and the grouped search keys are further
30 divided into up-directional search keys and down-directional search keys. Accordingly, it is possible to maintain pieces of processing block link information separately from not only each user but also the up-directional connection path and the
35 down-directional connection path.

In this embodiment, the upper 16 bits of a VLAN tag of 32 bits are set as "0x8100" and the

lower 16 bits are used for a user identifier VID, as illustrated in the bottom area of FIG. 4. It is noted that the symbol "0x" represents a hexadecimal number.

5 FIG. 5 is a flowchart of an exemplary connection operation performed by the management mechanism 20 according to one embodiment of the present invention.

10 Referring to FIG. 5, in response to receipt of a packet, the management mechanism 20 determines whether or not the destination of the received packet coincides with the MAC address thereof at step S10. If the received packet is not for the MAC address of the management mechanism 20 (S10: NO), the management mechanism 20 discards the packet at step S12 and then terminates the connection operation. On the other hand, if the received packet is for the MAC address of the management mechanism 20 (S10: YES), the control flow proceeds to step S14.

20 At step S14, the management mechanism 20 determines whether the received packet contains a VLAN tag. If the packet contains no VLAN tag (S14: NO), the management mechanism 20 discards the packet at step S16 and then terminates the connection operation. On the other hand, if the packet contains a VLAN tag (S14: YES), the control flow proceeds to step S18.

30 At step S18, the management mechanism 20 uses the detected VLAN tag as a search key to search the destination lookup table 22. If the corresponding VLAN tag is not detected in the destination lookup table 22 (S18: NOT HIT), the management mechanism 20 discards the packet at step S20 and then terminates the connection operation. On the other hand, if the corresponding VLAN tag is detected in the destination lookup table 22 (S18:

HIT), the control flow proceeds to step S22.

At step S22, the management mechanism 20 replaces the VLAN tag and the MAC address of the received packet with the VLAN tag and the MAC address detected from the destination lookup table 22, respectively. At step S24, the management mechanism 20 sends the resulting packet to an appropriate processing block via the physical port detected from the destination lookup table 22.

FIG. 6 is a flowchart of an exemplary connection operation performed by each of the processing blocks 24-1 through 24-n according to one embodiment of the present invention.

Referring to FIG. 6, in response to receipt of a packet, the processing block determines whether or not the destination of the received packet coincides with the MAC address thereof. If the received packet is not for the MAC address of the processing block (S30: NO), the processing block discards the packet at step S32 and then terminates the connection operation. On the other hand, if the received packet is for the MAC address of the processing block (S30: YES), the control flow proceeds to step S34.

At step S34, the processing block determines whether or not the received packet contains a VLAN tag. If the packet contains no VLAN tag (S34: NO), the processing block discards the packet at step S36 and then terminates the connection operation. On the other hand, if the received packet contains a VLAN tag (S34: YES), the control flow proceeds to step S38.

At step S38, the processing block operates in accordance with the operation policy of the user such as a firewall process, a server load balancing process, an encryption/decryption process. Based on a result of such a process, if the processing block

determines that the packet should not be relayed to another device any more (S38: NO), the processing block discards the packet at step S40 and then terminates the connection operation. On the other
5 hand, if the processing block determines to further relay the packet to another device (S38: YES), the control flow proceeds to step S42.

At step S42, the processing block replaces the MAC address of the received packet with the MAC
10 address "M0" of the management mechanism 20. At step S44, the processing block sends the resulting packet to the management mechanism 20.

FIG. 7 shows exemplary flow of an up-
15 directional packet according to one embodiment of the present invention.

Referring to FIG. 7, a packet supplied from user A to the management mechanism 20 contains the VLAN tag "VLANin_a". In accordance with the above-mentioned connection operation, the management
20 mechanism 20 replaces the VLAN tag and the MAC address of the received packet with the VLAN tag "VLAN1_a" and the MAC address "M1", respectively, with reference to the a1 line of the destination lookup table in FIG. 4, and then sends the resulting
25 packet to the processing block 24-1. In response to receipt of the packet from the management mechanism 20, the processing block 24-1 operates in accordance with the operation policy of user A. Then, the processing block 24-1 changes the MAC address of the
30 received packet into "M0" of the management mechanism 20, and sends the resulting packet to the management mechanism 20.

In response to receipt of the packet from the processing block 24-1, the management mechanism
35 20 replaces the VLAN tag and the MAC address of the received packet with the VLAN tag "VLAN2_a" and the MAC address "M2", respectively, and then sends the

resulting packet to the processing block 24-2. Similarly to the processing block 24-1, the processing block 24-2 operates in accordance with the operation policy of user A. Then, the
5 processing block 24-2 changes the MAC address of the received packet into "M0" of the management mechanism 20, and sends the resulting packet to the management mechanism 20. Similarly, the processing blocks 24-3 through 24-n sequentially perform some
10 predetermined processes on the packet supplied from user A in course of the connection path described in the destination lookup table 22. Finally, the management mechanism 20 replaces the VLAN tag and the MAC address of the packet received from the
15 processing block 24-n with the VLAN tag "VLANout_a" detected from the a5 line of the destination lookup table 22 and the MAC address "Mout" of the server, respectively, and then sends the resulting packet to the server side.

20 FIG. 8 shows exemplary flow of an down-directional packet according to one embodiment of the present invention.

Referring to FIG. 8, a packet supplied from the server to the management mechanism 20
25 contains the VLAN tag "VLANout_a". In response to receipt of the packet, the management mechanism 20 replaces the VLAN tag and the MAC address of the received packet with the VLAN tag "VLANn_a" and the MAC address "Mn" of the processing block 24-n,
30 respectively, with reference to the a6 line of the destination lookup table 22 in FIG. 4, and then sends the resulting packet to the processing block 24-n. As mentioned above, the processing block 24-n operates in accordance with the operation policy of
35 user A. Then, the processing block 24-n replaces the MAC address of the received packet into "M0", of the management mechanism 20, and sends the resulting

packet to the management mechanism 20.

Similarly to the up-directional connection operation, the remaining processing blocks 24-(n-1) through 24-1 performs some predetermined processes on the packet to be transmitted toward user A in course of the connection path described in the destination lookup table 22. Finally, the management mechanism 20 changes the VLAN tag and the MAC address of the packet received from the processing block 24-1 into "VLANin_a" detected from the a8 line of the destination lookup table 22 and the MAC address "Min" of user A, respectively, and sends the resulting packet to the client side.

In addition, the up-directional connection path for a packet supplied from user B is prescribed in the b1 through b4 lines of the destination lookup table 22 in FIG. 4. It can be seen from the destination lookup table 22 that the packet supplied from user B is processed through the processing blocks 24-2, 24-3, ..., 24-n sequentially.

Here, in order to add the processing block 24-1 to the head of the up-directional connection path for user B, the b1 line of the destination lookup table 22 in FIG. 4 is changed into the b0 and b1 lines of the destination lookup table 22 in FIG. 9. This change instruction is supplied from the terminal 30.

FIG. 9 is a diagram for explaining an exemplary change operation of the destination lookup table 22 according to one embodiment of the present invention.

Referring to FIG. 9, the b0 line indicates the VLAN tag "VLAN1_b" and the MAC address "M1" corresponding to the search key "VLANin_b". Namely, the b0 line indicates that a packet supplied from user B should be first sent to the processing block 24-1. Also, the b1 line indicates the VLAN tag

"VLAN2_b" and the MAC address "M2" corresponding to the search key "VLAN1_b". Namely, the b1 line indicates that the packet should be then sent to the processing block 24-2.

5 Furthermore, the up-directional connection path for a packet supplied from user X is prescribed in the c1, c2, ... lines of the destination lookup table 22 in FIG. 4. It can be seen from the destination lookup table 22 that the packet supplied
10 from user X is processed through the processing blocks 24-2, 24-3, ... sequentially.

 Here, in order to remove the processing block 24-2 from the up-directional connection path for user X, the c1 line of the destination lookup
15 table 22 is removed as illustrated in FIG. 9 and the search key of the c2 line is changed into "VLANin_x". This change instruction is supplied from the terminal 30.

 According to the above-mentioned change
20 instruction, it is possible to easily change connection paths of processing blocks for individual users by partially changing the destination lookup table 22 of the management mechanism 20. As a result, even in a case where similar type network
25 devices are used while different connection paths are set for individual users, it becomes unnecessary to change connection paths for a plurality of network devices by collecting pieces of information on the connection paths in the destination lookup
30 table 22 and collectively managing a plurality of users. Thus, it is possible to save an occupied installation area and decrease operational costs incurred by changing connection paths.

 Here, it is noted that above-mentioned
35 step S22 corresponds to a tag replacement and transmission part in the attached claims.

 The present invention is not limited to

the specifically disclosed embodiments, and variations and modifications may be made without departing from the scope of the present invention.